Information on Oil Well Fire Smoke in the Gulf War

Abstract/Summary

Shortly before the beginning of the ground phase of the Gulf War, Iraqi forces set fire to hundreds of oil wells in Kuwait. There was a great deal of concern about the potential health effects of the smoke from these fires. The oil smoke has been examined using satellite imagery, ground air monitoring, and dynamic computer modeling. Most particulate matter was less than 1.0 μm in diameter, a size that can be deeply respired. Total mass of suspended particulates in the near-field plumes typically ranged from 1-5 mg/m^3. To put the amount of smoke being emitted into perspective, the daily soot emitted from the oil well fires was estimated to be about 13 times that emitted from all combustion sources in the United States. The density and particulate size are also of concern, as the proposed National Ambient Air Quality Standard for 24-hour particulate matter of less than 2.5 μm diameter is 65 $\mu g/m^3$.

There is no proof of long-term adverse effects of exposure to the oil well fire smoke, and only limited evidence of any effect. Only two post-war studies related to exposure to the oil fire smoke have been identified, and neither has yet been published in a peer-reviewed journal, although both have been presented in scientific meetings. In a study using computer modeled plume data, no increase in risk of DoD hospitalization (overall or for respiratory problems) was identified. Another study of CCEP participants found a 40 percent increase in the likelihood of a diagnosis of asthma among the most heavily exposed Gulf War veterans.

Background

In February 1991, shortly before the beginning of the ground phase of the Gulf War, Iraqi forces set fire to about 605 oil wells. The dramatic photographs and reports of the fires and smoke raised health concerns for the thousands of potentially exposed American troops. In 1992 the 102nd Congress responded to this concern by passing provisions of PL 102-190 (National Defense Authorization Act for Fiscal Years 1992 and 1993) that required the Secretary of Defense to establish a registry of military personnel who were exposed to the fumes of oil well fires. This registry is to contain descriptions of exposure for each individual. This law also requires the Secretary of Defense to annually report the results of all ongoing studies to determine the health consequences of the exposure to the oil well fires.

In the years following the Gulf War, the Department of Defense initiated a number of programs to address the concerns of veterans and Congress. The Comprehensive Clinical Evaluation Program organized and coordinated medical evaluation of active duty Gulf War veterans. [1 2 3] The U.S. Army Center for Health Promotion and Preventive Medicine in conjunction with the U.S. Armed Services Center for Unit Records Research developed a geographic information system to locate and track military units in the theater of operations. [4] Through a collaborative effort, the National Oceanographic and Atmospheric Administration's Air Resources Laboratory and the Center for Health Promotion and Preventive Medicine's Deployment Environmental Surveillance Program developed a model of the oil well fire smoke. [5 6]

In its final report of 1996, the Institute of Medicine commented on the value of utilizing the integrated geographic information system to estimate exposure to oil well fire smoke. [7]

While human health risk assessments of the chemical constituents have been conducted, [4] there is little epidemiologic information evaluating the actual impact of the fires on the health of the military personnel. No official or peer-reviewed published reports have been identified that evaluate the prevalence or incidence of respiratory conditions during the war. However, a letter from the Pulmonary and Respiratory Therapy Consultant to the Surgeon General (Army) to the Chief of the Medical Corps, dated 27 December 1991, provides some limited information. [8] The letter reports that approximately 200 soldiers were evacuated from the theater of operations with a diagnosis of asthma, and that 13 percent of these were for their first occurrence. In 1993, the Department of Defense published a report to Congress regarding exposure to smoke from the oil fires. [9] One section of this report provided an epidemiologic assessment of acute effects among three groups of U.S. Marines. Each group had a different level of exposure, in terms of intensity and duration, to the oil fire smoke. The Marines were interviewed via questionnaire between March 14 and 31, 1991, while the fires were still burning. Group I, which had the highest exposure to smoke, had a significantly higher prevalence of self-reported wheezing (odds ratio = 3.1), cough (odds ratio = 1.5), runny nose (odds ratio = 1.5), and sore throat (odds ratio = 1.5) than did Group III, which had the lowest exposure.

Respiratory diseases in general and asthma specifically were relatively common primary diagnoses among Comprehensive Clinical Evaluation Program participants. [1] A primary

diagnosis involving the respiratory system was reported for 6.8 percent of participants, while 17.5 percent had a primary or secondary diagnosis involving the respiratory system. Asthma, unspecified (ICD-9-CM 493.9), was reported as a primary diagnosis for 2.2 percent of the participants (prevalence as a secondary diagnosis was not reported). The prevalence of asthma in the general population has been estimated to be from 4 to 8 percent. [10]

Oil Well Fire Smoke Model

The National Oceanic and Atmospheric Administration Air Resources Laboratory (Silver Spring, MD) constructed an atmospheric advection and diffusion model. This model evaluated oil fire smoke (i.e., soot) by predicting spatially (resolution of 15 km) and temporally (24 hour average) concentrations at 2 m above the terrain. [5 6] The model was developed using input from satellite imagery and ground station air monitoring data. Emission rates were developed using extinguishment chronologies developed by the National Oceanic and Atmospheric Administration Arabian Gulf Program Office and Kuwaiti crude oil composition data. More data on the oil fires is available from Husain. [11] Most of the particulate matter was between 0.1 and 0.8 μm in diameter. Total mass of suspended particulates in the near-field plumes typically ranged from 1-5 mg/m^3.[12] Black smoke fires comprised 60-65 percent of the oil well fires, and elemental carbon was the primary carbonaceous particulate component of these. White plumes contained little soot. Other substantial components of the plumes included sodium and calcium salts and sulfates. [11 12] The composite “super plume” was composed of about 30 percent salts, 8 percent sulfates, 30 percent organic compounds, and 15 percent to 20 percent soot, with

the balance not specified.[13] Thus, since the models considered only soot, the total suspended particles may have been at levels five to seven times as great as the estimates utilized in this study.

Based on samples collected while the wells were still burning, the fires produced particles of a size (0.1 to 0.8 μm) that would be deeply inspired and likely to be retained in the lungs. Estimates of TSP less than 3.5 μm in diameter in plumes were 840 $\mu g/m^3$ 20 km downwind of the fires, and 210 $\mu g/m^3$ 160 km downwind. [13] Hobbs estimated the daily soot emitted to be 13 times that emitted from all combustion sources in the United States. [13]

Health studies of exposure to smoke from oil well fires.

To put the amount of smoke being emitted into perspective, the daily soot emitted from the oil well fires was estimated to be about 13 times that emitted from all combustion sources in the United States. The density and particulate size are also of concern, as the proposed National Ambient Air Quality Standard for 24-hour particulate matter of less than 2.5 μm diameter is 65 $\mu g/m^3$. Based on the chemical constituents of the smoke, a human health risk assessment concluded that there was little risk from exposure, but this assessment did not consider particulate size. There is no proof of long-term adverse effects of exposure to the oil well fire smoke, and only limited evidence of any effect. There is very limited information available on the actual health effects of exposure to the smoke from the oil well fires among Gulf War veterans. Only two post-war studies related to exposure to the oil fire smoke have been identified, and neither has yet been

published in a peer-reviewed journal, although both have been presented in scientific meetings.

A study of oil well fire smoke and post war hospitalization was reported at the 2001 Conference on Illnesses among Gulf War Veterans: A Decade of Scientific Research (Smith, et al., 2001). In this study modeled smoke plume data was utilized to estimate exposures, and DOD hospitalization data was used to measure outcomes [14]. No increases in risk of hospitalization were identified, either overall or for diagnoses thought to be potential chronic manifestations of heavy oil well fire smoke exposure. A significant association was found for "injury and poisoning", with a risk increase of 5 percent. No potential mechanism for this association was offered.

A case-control study of asthma among CCEP participants was conducted by Cowan and colleagues (Cowan, et al., 1998a; Cowan, et al., 1998b). All study subjects were Gulf War veterans. Cases in this study were CCEP participants who received a physician-assigned diagnosis of asthma as a result of the exam, while controls were participants who had no respiratory diagnoses, complaints, or symptoms. Utilizing two measures of cumulative exposure, an increase in risk of asthma diagnosis of approximately 40 percent was identified, for the most heavily exposed veterans. A dose-response relationship was also observed for both measures of exposure. At the time of the study it was not possible to differentiate between new and exacerbated cases of asthma, or to determine the criteria for assigning the diagnosis.

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